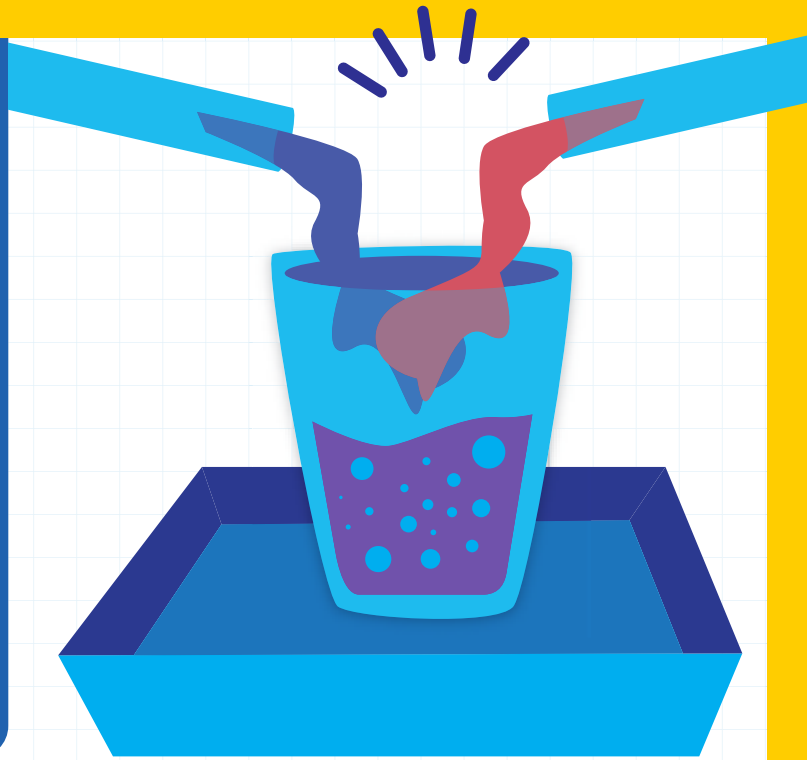
NATIONAL GEOGRAPHIC

MEGA SCIENCE SERIES

AMAZING REACTIONS

CHEMISTRY SET



WARNING:
This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Experiment Guide

ATTENTION PARENTS AND YOUNG SCIENTISTS!

How to Safely Conduct Your Experiments

Wear Your Safety Goggles

The experiments in this kit are real chemical reactions that can cause splashes, fumes, and dust that may irritate or damage eyes and skin. Wearing safety goggles is recommended for safe, active learning. All real scientists wear them!

Adult Supervision Is Recommended for All Experiments

Read the instructions and cautions on the containers carefully. Do not ingest any of the chemicals in the kit. If swallowed, wash out mouth with water and drink some fresh water. If something gets splashed in the eyes or on skin, flush thoroughly with water. Keep all the contents of this kit out of reach of young children and pets.

Maintain a Clean Workspace

It's important to conduct ALL experiments on the experiment tray for easy cleanup. We recommend wearing old clothes that can get dirty, as some of the ingredients in the kit might stain. Set out all the materials before starting an experiment so you can work safely. Roll up bags for later use.

Measure Carefully

Amounts were carefully selected to give consistent, predictable results. Measuring carefully will also ensure your materials last so you can do more experiments!

Wash Your Hands and Tools After Every Experiment

Use warm water and soap to thoroughly wash your hands and tools after performing your experiment.

Everything in the universe, from the most distant stars to the drops of water in your bathtub, is made of atoms. Those atoms link up with other atoms, creating bonds to form molecules. But the molecules can be broken up and the atoms recombined to form a different molecule—or two or four or twelve!

When two or more molecules interact and change to become other kinds of molecules, that's a chemical reaction. With these experiments, you will be able to test out different chemical reactions. You'll see how chemical reactions produce gas, how acids and bases differ, how they combine, and how two liquids can combine to produce a solid.

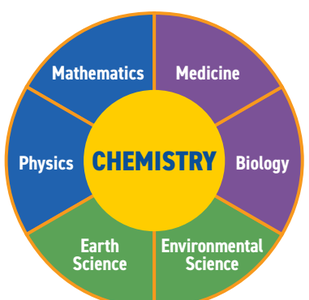
But just what IS chemistry?

Chemistry is called the "central science."

The science of chemistry studies how atoms and molecules are structured and what happens when they react with one another. For this reason, all the different kinds of science—biology, physics, astronomy, medicine, and more—rely on chemistry.

Chemistry is in everything.

Knowing how chemical processes work allows us to understand how our bodies stay healthy, how plants produce oxygen, and how silicon chips can be used to make smartphones. Farmers rely on chemistry to grow the best crops, and chefs use it to combine foods to make the tastiest meals. Astronomers study the gases burned by stars and marine biologists look to chemistry to explain how tiny plankton and krill provide enough energy to feed enormous whales.



Learn the fundamentals of chemistry.

Throughout this book, look for sections labeled SERIOUSLY SCIENTIFIC. They'll give you key information that real chemists use to understand how things work.

Think Like a Scientist

Are You a Scientist?

If you are the kind of person who likes to know things, then you have the makings of a real scientist, because science is all about knowing stuff about the world around us. In fact, the word *science* comes from the Latin words for "having knowledge."

Use the Scientific Method

Scientists use a special process called the *scientific method* to figure out how things work. Try this: before conducting an experiment, come up with a question you'd like to answer. Once you have your **question**, **research** your topic, **guess** what will happen, do the **experiment**, **analyze** the results, and **conclude**! (The bold words are essential steps in the scientific method.) The scientific method is the cornerstone of modern science. Without this method, we wouldn't have the scientific knowledge we have today. You can record your questions, guesses, and conclusions on the pages at the end of this booklet.

Pay Attention!

Whenever a chemical reaction occurs, something changes. Observe your experiments carefully to look for all the things that might change:

- Did bubbles form?
- Did the color change?
- Did the solution get hotter or colder?
- Did you smell anything different?
- Did a solution become clearer or cloudier?
- Did solids form from liquids?

Know Your Tools

A. pH indicator paper
B. Colorless crayon
C. Spray bottle
D. Test tubes with holders
E. Beaker
F. Tall cup
G. Short cup
H. Foam
I. Crystal tree display base
J. Paper tree
K. Washable markers
L. Safety goggles
M. Cleaning brush
N. Medium scoop (⅛ tsp / 0.6 mL)
O. Big scoop (½ tsp / 2.5 mL)
P. Paper straw
Q. Bouncy ball mold
R. Pipette
S. Small scoop (⅛ tsp / 0.6 mL)
T. Experiment tray

Have an adult carefully cut open bags with powder inside before you begin. When your experiments are complete, roll the bags up and seal them with a rubber band or clip to avoid mess.

Color-Changing Chemistry

AMAZING ACIDS & AWESOME ALKALINES

Do you like the tangy taste of orange juice or lemonade? How about sour gummy worms? That sharp tang comes from an *acid*, and with these experiments you will witness the incredible color-changing chemistry of acids and their opposite, *alkalines.*

SCIENTIST TIP

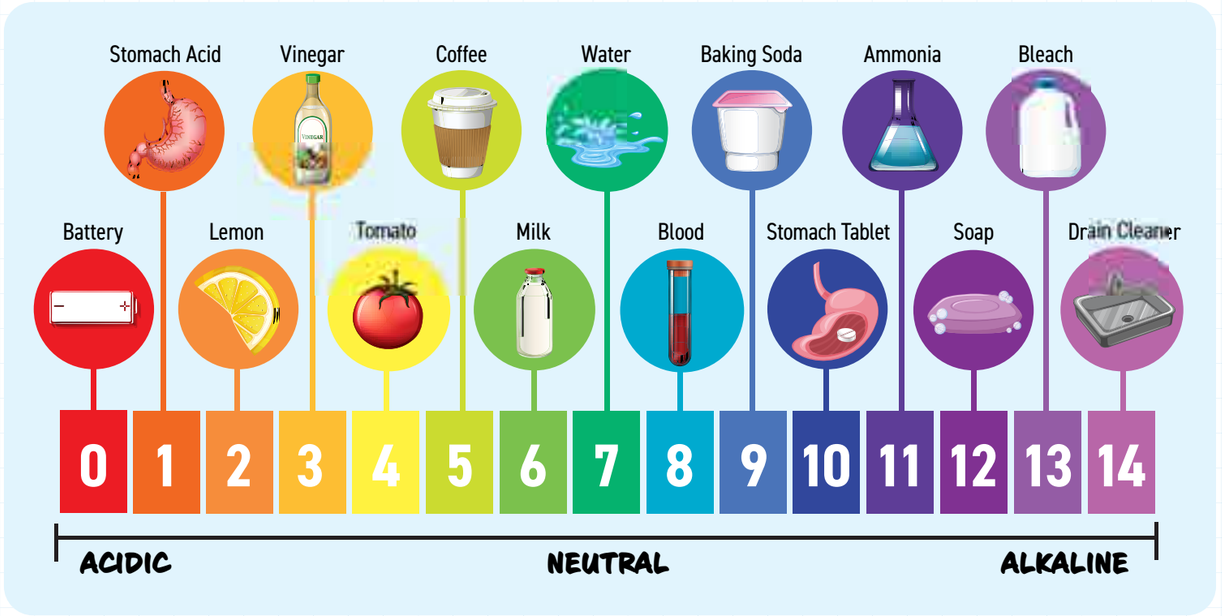
Wash and dry your beaker, cups, and spoons thoroughly before beginning your next experiment. This will prevent contamination and give your experiments the best results!

SERIOUSLY SCIENTIFIC

pH Stands for Potential Hydrogen

When something has lots of electrically charged hydrogen atoms—called *hydrogen ions*—then that substance is an acid. When a substance has lots of hydroxide ions, then it is an alkaline—also referred to as a *base.* pH stands for "potential hydrogen" and when you take a pH reading you discover how many hydrogen ions are in the sample. The results fall on a scale of 0 to 14, with 0 being the most acidic and 14 being the most alkaline. Completely pure water will register right in the middle at 7 and is considered *neutral.* Anything below that is acidic and anything above is alkaline.

TRY THIS! *Check out the scale below and use the red cabbage powder or pH paper from this kit to test the pH of things around your house!*



Make It Red with an Acid!

In this experiment we'll use powdered red cabbage to make an indicator solution and then see what color results when it mixes with an acid.

FROM THE KIT:

- Red cabbage powder
- Citric acid
- Test tube
- Tall cup
- Pipette
- Small scoop
- Medium scoop

WHAT TO GET:

- Water

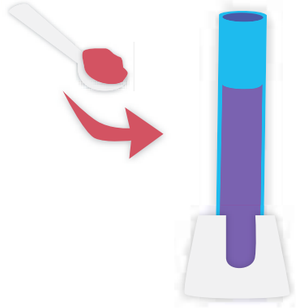
Safety First! *Make sure to use your safety goggles and experiment tray.* ***Caution:*** *Adult supervision required for younger children. Red cabbage powder can stain skin and other surfaces.*

WHAT TO DO:

1

Fill the test tube ¾ full of water.

2



Add 1 small scoop of red cabbage powder to the water and stir until the powder is completely dissolved. The solution you just created is your indicator.

3

Fill the tall cup ½ full of water.

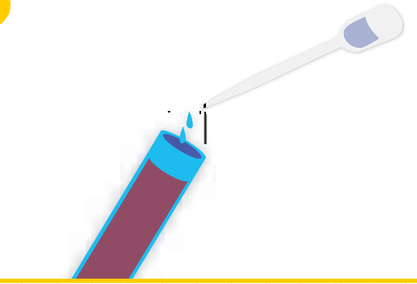
4

Add 1 medium scoop of citric acid to the cup and mix well until the crystals are completely dissolved. This is your acidic solution.

5

Fill your pipette with the acidic solution.

6



Using the pipette, slowly add the acidic solution to the indicator. Stir the indicator while you add the acidic solution and the solution will change colors from purple to bright red!

SERIOUSLY SCIENTIFIC

What's an indicator?

Chemists tell how acidic a liquid is by using an *indicator*—something that reacts in different ways when it comes into contact with either an acid or a base (the opposite of an acid). Red cabbage contains a pigment (called *anthocyanin*) that acts as an indicator: when it touches an acid, it turns red; when it touches a base (the opposite of an acid), it turns blue.

Make It Blue with a Base!

Next, we'll see what color results when a pH indicator mixes with an alkaline (or base).

FROM THE KIT:
- Red cabbage powder
- Baking soda
- Test tube
- Tall cup
- Pipette
- Small scoop
- Medium scoop

WHAT TO GET:
- Water

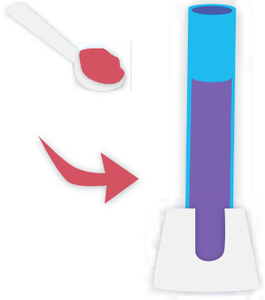
Safety First! *Make sure to use your safety goggles and experiment tray.* ***Caution:*** *Adult supervision required for younger children. Red cabbage powder can stain skin and other surfaces.*

WHAT TO DO:

1

Fill the test tube ¾ full of water.

2



Add 1 small scoop of red cabbage powder to the water and stir until it's all dissolved and you have a purple liquid. This is your indicator.

3

Fill the tall cup ½ full of water.

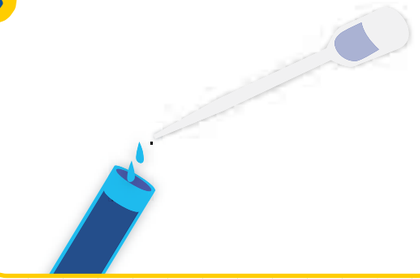
4

Add 1 medium scoop of baking soda to the cup and mix well until the liquid is clear. This is your base solution.

5

Fill your pipette with the base solution.

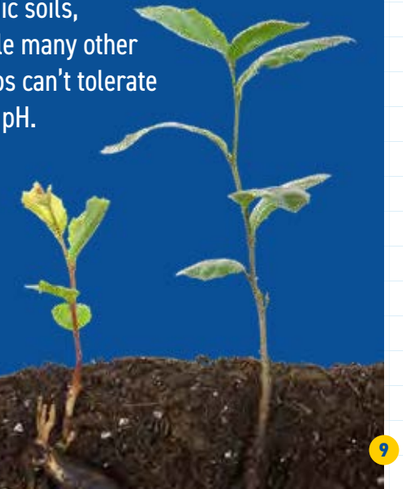
6



Using the pipette, slowly add the base solution to the indicator. Stir the indicator while dripping in the base solution, and the indicator will change colors from purple to a nice deep blue!

AMAZING FACTS!

Farmers rely on the soil to grow healthy crops, so they will measure the pH of their soil to see if it's acidic or alkaline. Knowing the pH of the soil tells farmers a lot about whether the soil will be able to support a specific crop. Blueberries and white potatoes, for example, require highly acidic soils, while many other crops can't tolerate low pH.



The Power of Purple

Now use your color-changing skills with acids and bases to create a big bubbling reaction!

FROM THE KIT:

- 2 test tubes
- Red cabbage powder
- Citric acid
- Baking soda
- Small scoop
- Big scoop
- Beaker
- Tall cup

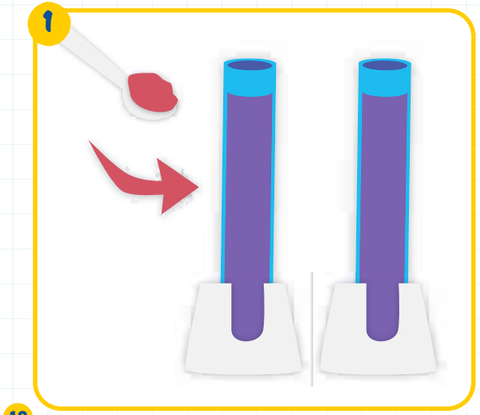
WHAT TO GET:

- Room temperature tap water

Safety First! *Make sure to use your safety goggles and experiment tray!*

WHAT TO DO:

1

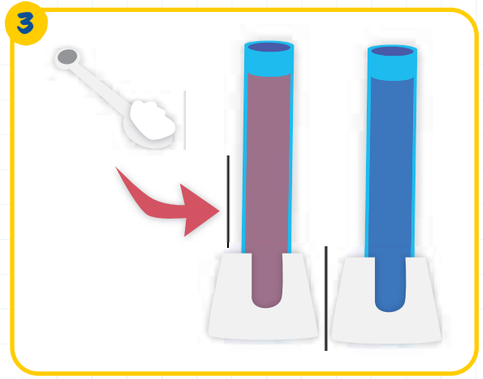


Use the beaker to measure 50 mL of water into each test tube. Add 1 small scoop of red cabbage powder to each test tube and stir to dissolve.

2

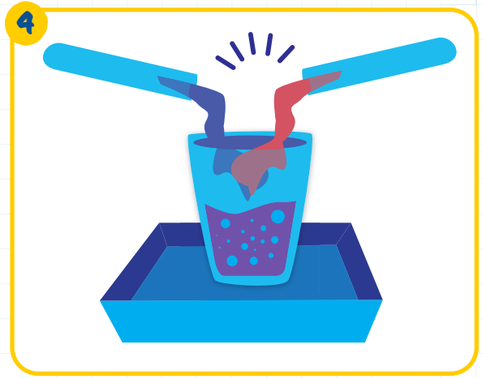
Add 1 big scoop of baking soda to one of the test tubes and stir to dissolve. The solution turns blue! This is your basic solution.

3



Add 1 big scoop of citric acid to the other test tube and stir to dissolve. The solution turns red! This is your acidic solution.

4



Place the tall cup onto the experiment tray and pour the two solutions into it at the same time. A fizzy reaction occurs as the liquid changes to purple!

WHY DID THAT HAPPEN?

When baking soda and citric acid solutions react chemically, they produce water, sodium citrate, and carbon dioxide gas. It's the carbon dioxide that makes the mixture froth and foam.

SERIOUSLY SCIENTIFIC

Making Solutions

A *solution* is essentially two substances that are evenly mixed. When you work with chemistry or even cook in your kitchen, you will often dissolve solids into liquids. However, solutions can also be gases dissolved in liquids, such as carbonated water. Solutions can also be gases in other gases, like the air that surrounds us every day, and liquids in liquids, such as the antifreeze in cars.

Reveal a Secret Message

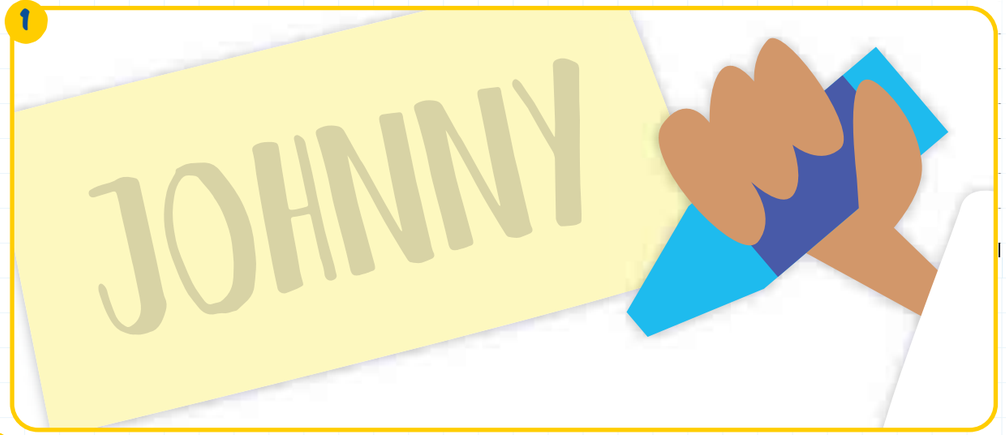
FROM THE KIT:
- Citric acid
- 1 piece of pH paper
- Colorless crayon
- Spray bottle
- Medium scoop

WHAT TO GET:
- Warm water

Safety First! *Make sure to use your safety goggles and experiment tray!*

WHAT TO DO:

1



Write your name or a secret message on the pH paper with the crayon. ***Tip:*** *It helps to write firmly with the crayon so it will display clearly when revealed.*

2

Pour 1 medium scoop of citric acid into the spray bottle. Fill the bottle about ¾ full of warm water. Replace the cap and shake the bottle until the citric acid is dissolved.

3

Hold the pH paper about 6 inches (15 cm) from the bottle, spray where your message is written, and the pH paper will turn red, revealing your hidden message!

WHY DID THAT HAPPEN?

The pH paper is an *indicator* that visually shows the pH value of a liquid. When a liquid's pH value is acidic, the paper will turn a red color. When a liquid's pH value is alkaline, the paper turns blue!

AMAZING FACTS!

There are many strong acids and bases in nature that serve important functions. For example, some insects and animals will use acids and bases as dangerous poisons. In other cases, plants use them in their leaves, seeds, or sap to deter predators or prevent diseases.

Hide a Secret Message

FROM THE KIT:
- Baking soda
- pH paper with revealed message
- Short cup
- Foam
- Medium scoop

WHAT TO GET:
- Water

Safety First! *Make sure to use your safety goggles and experiment tray!*

WHAT TO DO:

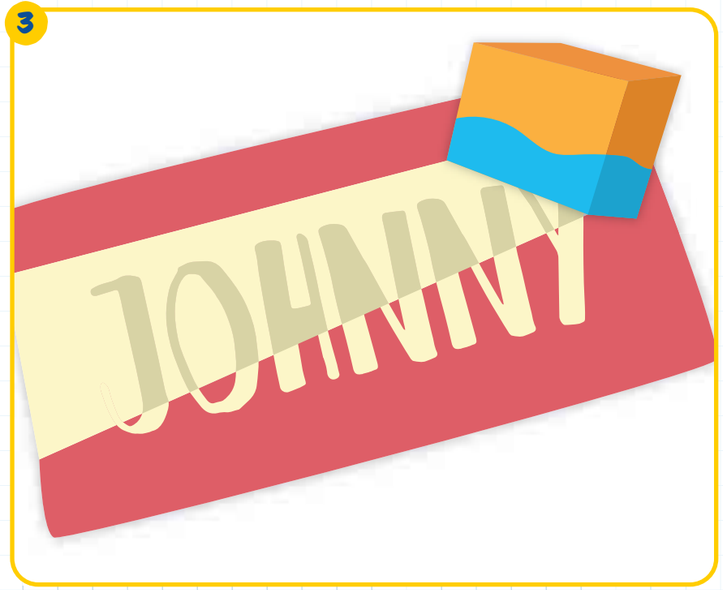
1

Use the pH paper with the message you revealed earlier. ***Tip:*** *For best results, let the paper dry thoroughly before hiding your message.*

2

Fill the short cup ½ full of water. Add 1 medium scoop of baking soda and stir well until the baking soda is completely dissolved.

3



Dip the foam in the solution, then dab it across your message. The pH paper will turn from red back to yellow as you neutralize the acid with the base solution. If you continue to dab the yellow parts of the paper, it will eventually turn blue!

WHY DID THAT HAPPEN?

Acids and bases can be used to neutralize one another. When you made the pH paper red, you used an *acidic* solution and lowered the pH level. But by using a small amount of a *basic* solution (like you did with the baking soda) you raised the pH level of the paper back toward neutral. If you add too much base, though, the paper will turn blue!

Atomic Fizz

If a solution that is high on the pH scale (a base) mixes with one that is low on the pH scale (an acid), can they cancel each other out? In this experiment you'll see how the indicator changes as the solution moves from basic to acidic.

FROM THE KIT:

- 2 test tubes
- Citric acid
- Baking soda
- Phenol red
- Medium scoop
- Big scoop
- Beaker
- Tall cup

WHAT TO GET:

- Water

Caution: *Phenol red can stain clothing, skin and other surfaces. Please handle with care.*

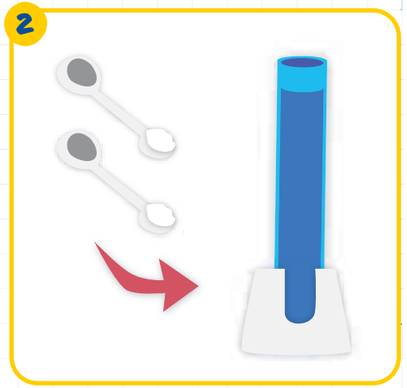
Safety First! *Make sure to use your safety goggles and experiment tray!*

WHAT TO DO:

1

Measure 20 mL of water with your beaker and pour it into the first test tube. Using your pipette, add 5 drops of phenol red and stir. This is your indicator.

2

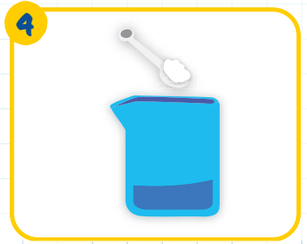


Measure 50 mL of water with your beaker and pour it into the second test tube. Add 2 medium scoops of baking soda and stir until the powder is dissolved. This is your basic solution.

3

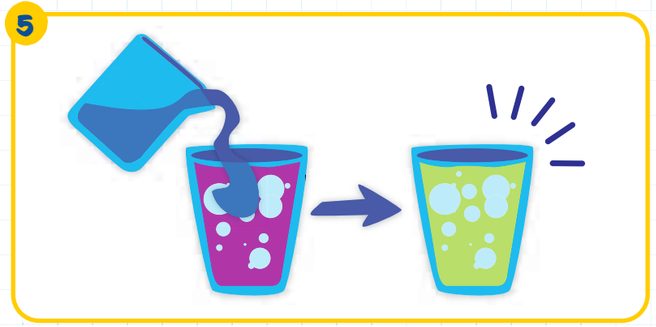
Pour both the indicator and basic solution from the test tubes into the tall cup. The solution turns pink, indicating a high pH level.

4



Add 20 mL of water to your beaker. Add 1 big scoop of citric acid and stir until the crystals are dissolved. This is your acidic solution.

5



Now, pour the acidic solution from the beaker into the tall cup. The solution fizzes and changes color from pink to atomic yellow!

WHY DID THAT HAPPEN?

Phenol red is an indicator that turns pink in solutions that are basic (like baking soda) and yellow in solutions that are acidic (like citric acid). When baking soda and citric acid dissolve in water and meet up, they create a chemical reaction that forms carbon dioxide gas.

SERIOUSLY SCIENTIFIC

What's a Chemical Reaction?

In a chemical reaction, molecules crash into each other with enough energy to break the original bonds between atoms and form new bonds, which creates new molecules. The starting materials (the *reactants*) change into (*yield*) new chemical substances (*products*). In this experiment, the reaction created carbon dioxide gas as a product, which made the solution fizz.

Drop by Drop

Chemistry is a very exact science, as a single drop can change the nature of a solution. In this experiment, you'll use a dropper to change the pH of a solution, drop by drop, until it changes from a base to an acid. Count carefully and record your findings in the chart.

FROM THE KIT:

- 1 test tube
- Phenol red
- Sodium carbonate
- Small scoop
- Citric acid
- Medium scoop
- Beaker
- Pipette

WHAT TO GET:

- Water

NOTE: *If your water does not turn pink or red when phenol red is added in Step 2, let the cup sit on the kitchen counter for a few hours and the solution will change color.*

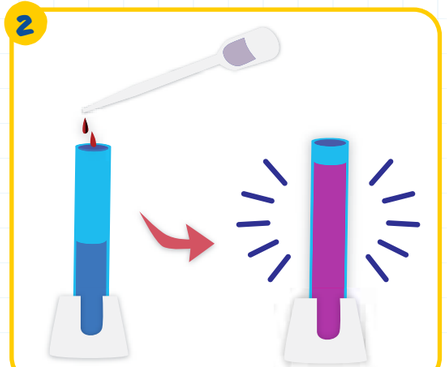
CAUTION: *Phenol red can stain clothing, skin and other surfaces. Please handle with care.*

WHAT TO DO:

1

Measure 30 mL of water in the beaker and pour it into the test tube. Add 1 small scoop of sodium carbonate and stir until the powder is dissolved. This is your basic solution.

2

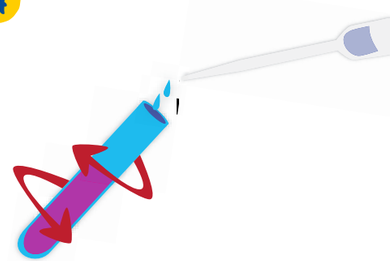


Using your pipette, add 5 drops of phenol red to the test tube. The solution changes to pink, as the phenol red detects a high pH level.

3

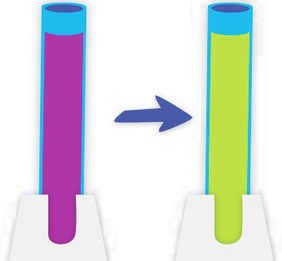
Measure 30 mL of water in the beaker. Add one medium scoop of citric acid and stir until the crystals are dissolved. This is your acidic solution.

4



Fill your pipette with the acidic solution from the beaker then add drops to the test tube—4 or 5 at a time. Keep count of the drops and swirl the test tube to see how the color changes.

5



Keep adding drops and swirling the test tube until the solution changes color. How many drops did it take to turn the solution from alkaline to acid? Record your observations in the table to the right!

COUNT THE DROPS!

COLOR	NUMBER OF DROPS
PINK (Alkaline)	
ORANGE (Slightly Acidic)	
YELLOW (Acidic)	

Blow It Away

Is your breath powerful enough to change the color of a solution? This experiment will show you how the air that you exhale has the chemical properties that will change a solution from a base to an acid—just by blowing through a straw!

FROM THE KIT:

- Test tube
- Tall cup
- Pipette
- Phenol red
- Straw

WHAT TO GET:

- Water
- Your breath

Note: *Not all tap water is the same, because city sanitation systems add different things to purify the water. If your water does not turn pink or red when phenol red is added in Step 2, let the cup sit on the kitchen counter for a few hours and the solution will change color.*

WHAT TO DO:

1

Measure 50 mL of water in the test tube and pour it into the tall cup.

2

Fill your big pipette with phenol red and add 5 drops to the cup of water. Stir the solution. This is your indicator.

3

Using the straw, SLOWLY blow air into the indicator. Be careful to blow gently so the solution does not splash.

4

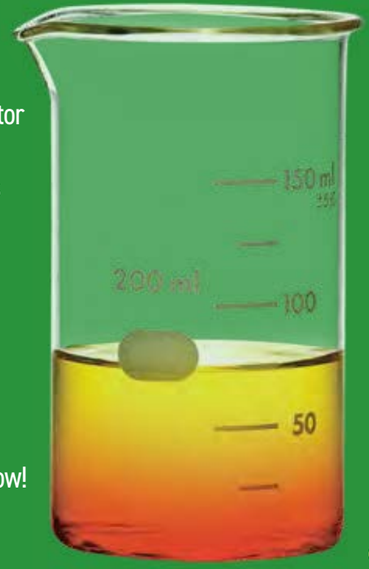
Watch for the solution to change color from red to yellow!

TRY THIS!

After making the water acidic with your breath, leave the cup out overnight and see what happens. If it turns pink, that means it has become more alkaline. This happens because of the chlorine that is added to drinking water by most city sanitation systems. Chlorine reacts with water to make hydrochloric and hypochlorous acids that help kill harmful bacteria. As the chlorine evaporates overnight, the acids disappear and the water becomes more alkaline.

WHY DID THAT HAPPEN?

The red solution is mostly water—H_2O— and your breath when you exhale is filled with carbon dioxide, CO_2. When water and carbon dioxide react, they form carbonic acid, and you already know what happens to the phenol red indicator when a solution is acidic. As the water becomes more strongly acidic, the solution turns yellow!



Turbid-Charged!

The word *turbid* is from the Latin *turba* meaning "a crowd" or "a disturbance." A solution is turbid when it contains a large number of individual particles that would normally be invisible to the naked eye. The solid particles are suspended in the solution, making it hazy or muddy.

FROM THE KIT:

- 2 test tubes
- Sodium carbonate
- Calcium chloride
- Citric acid
- Medium scoop
- Big scoop
- Beaker
- Tall cup

WHAT TO GET:

- Water

Safety First! *Make sure to use your safety goggles and experiment tray.*

WHAT TO DO:

1

Measure 30 mL of water in the beaker and add it to the tall cup. Add 1 medium scoop of sodium carbonate and stir until the powder is completely dissolved.

2

Measure 30 mL of water in the beaker and add it to the first test tube. Add 2 medium scoops of calcium chloride and stir until the powder is completely dissolved.

3

Pour the clear solution from the test tube into the clear solution in the tall cup. The result is a milky white solution.

4

Measure 50 mL of water in the beaker and add it to the second test tube. Add 1 big scoop of citric acid and stir until the crystals are completely dissolved.

5

Pour the clear citric acid solution into the milky solution in the tall cup, and watch the water gradually become clear once more.

WHY DID THAT HAPPEN?

Mixing the sodium carbonate solution and calcium chloride solution together causes a chemical reaction that creates a *precipitate* of tiny granules of calcium carbonate. This is the same compound that makes up eggshells and pearls. These white granules do not dissolve in water, so the mixture becomes turbid. Adding the acidic solution dissolves those the tiny granules, so the solution becomes clear again.

Make a Glowing Test Tube

All light is a form of energy, so to create light you need an energy supply. With incandescence, the light comes from heat energy—like when you turn on an electric stove and the coil glows red. In this experiment, we'll explore luminescence, where light is emitted without heat.

FROM THE KIT:
- 1 test tube
- Zinc sulfide
- Medium scoop
- Short cup

WHAT TO GET:
- Warm water
- Lamp or UV light

Safety First! *Make sure to use your safety goggles and experiment tray.*

WHAT TO DO:

1

Measure 50 mL of water in the beaker and add it to the test tube.

2

Add 1 medium scoop of zinc sulfide to the short cup and spread the powder out evenly.

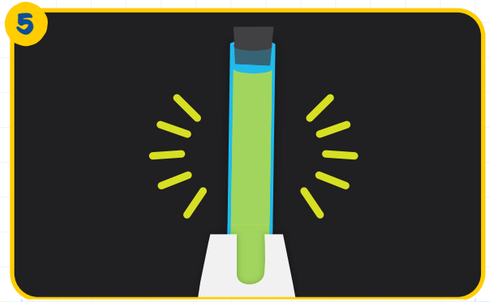
3

Let the powder sit directly under a lamp or UV light for 1–5 minutes. The longer the powder absorbs the light, the longer and brighter it will glow!

4

Add the zinc sulfide to the test tube and stir for 30 seconds.

5



Put the cap on the test tube and look at your test tube in the dark! If the glow-in-the-dark powder settles to the bottom of the test tube, just shake it up!

WHY DID THAT HAPPEN?

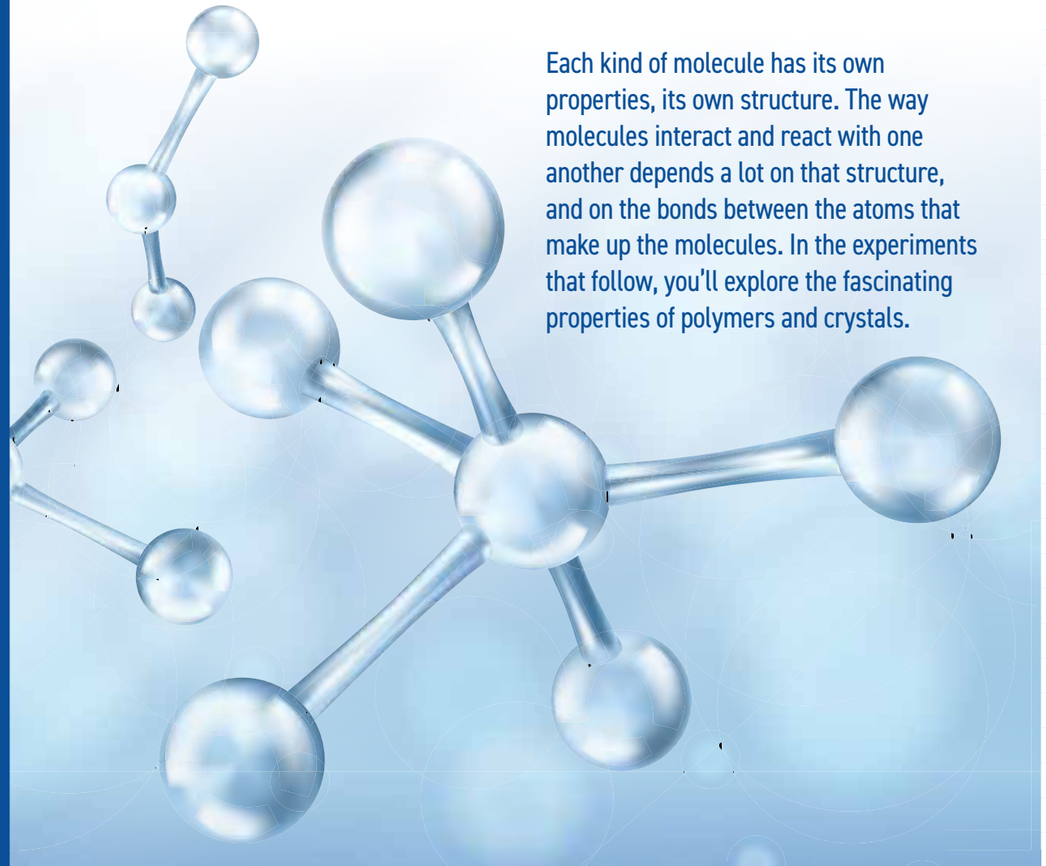
In *luminescence*, an energy source kicks an electron out of its normal stable state into a higher-energy excited state; the energized electron gets rid of the extra energy in the form of light so that it can fall back to its normal or *ground* state. In a phenomenon called *phosphorescence* the light energy is stored and continues to be emitted even after the original source of energy is removed.

SERIOUSLY SCIENTIFIC

What is phosphorescence?

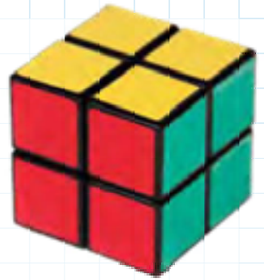
Shining a lamp on zinc sulfide provides added energy that excites the chemical's electrons. Because the electrons take a while to relax back to their normal state, the "glow" lasts even after the light is removed. The more energy that's absorbed (that is, the longer you leave the zinc sulfide powder under the light), the longer the glow will last. Once the glow fades, you can "recharge" the solution by putting it back under the light. However, since the water in the test tube will absorb some of the light's energy, it may take a lot longer to get the solution to glow again.

Polymers and Crystals



Each kind of molecule has its own properties, its own structure. The way molecules interact and react with one another depends a lot on that structure, and on the bonds between the atoms that make up the molecules. In the experiments that follow, you'll explore the fascinating properties of polymers and crystals.

Polymers are large molecules made up of repeating units. (*Poly* is the Greek word for "many" and *mer* means "unit".) They can be three-dimensional, like a Rubik's Cube; two-dimensional, like a woven placemat; or one-dimensional, like a long string of beads. Depending on the type of molecules and how they are attached, polymers can do amazing things. They can stretch and bend, like polyester, or be stiff and durable, like glass.



Crystals are solid structures formed when atoms or molecules line up in regular, three-dimensional patterns. Some crystalline materials, such as gemstones, can be single crystals; others, such as metals, are made up of large numbers of small crystals that are joined together. The form of a crystal depends upon the substance of which it is made. Under different conditions of temperature and pressure, the same type of substance may crystallize in different forms. For example, carbon has two distinct crystalline forms—diamonds and graphite.

Make a Colorful Bouncy Ball

FROM THE KIT:

- Polymer powders—red, blue, and green
- Bouncy ball mold
- Tall cup

WHAT TO GET:

- Cold water
- Paper towel

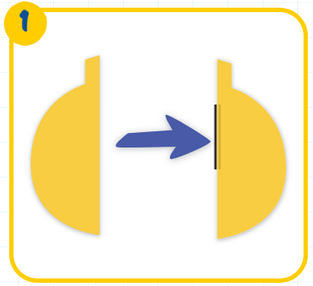
Safety First! *Make sure to use your safety goggles and experiment tray.*

When you are done with the bouncy ball, it can be safely thrown in the trash. Do not put down the sink.

This experiment takes longer than the others. ***Total time is up to 35 minutes.***

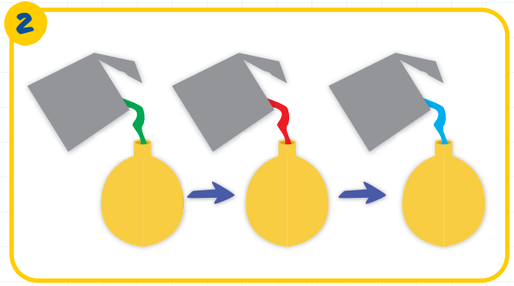
WHAT TO DO:

1



Assemble the bouncy ball mold by snapping it together.

2



Pick your first color of polymer powder and carefully pour the entire bag into the mold. Tap the mold on the table to settle the powder. Repeat this step for the next two colors.

3

Fill the tall cup ⅔ full of water.

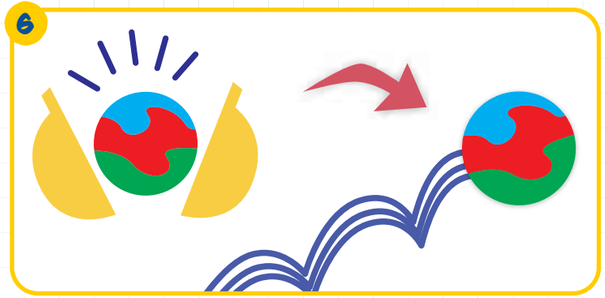
4

Submerge the powder-filled mold in the water and hold it underwater to allow air to escape. Once the bubbles stop, let go of the mold and let it sit in the water for 20 minutes.

5

Take the mold out of the water and let it sit on a paper towel for 15 minutes to allow the polymers to harden.

6



Carefully open the mold and remove your bouncy ball. Have fun!

SERIOUSLY SCIENTIFIC

Polymer chains

Some of the most important and interesting polymers are structured like a long chain. The DNA that stores all the genetic information for a living organism is a polymer, as is the hair on your head and the silk in a spider's web. Man-made polymers include rayon, nylon, and polyester (materials often used to make clothing).

Make Instant Worms

Sodium alginate is a naturally occurring polymer that has dozens of uses. It's found as a thickener and stabilizer in foods, cosmetics, and medicines. However, we'll use it to make colorful worms.

FROM THE KIT:
- Sodium alginate solution
- Calcium chloride
- Tall cup
- Medium scoop

WHAT TO GET:
- Water

Safety First! *Make sure to use your safety goggles and experiment tray.*

When you are done with the worms, they can be safely thrown in the trash. Do not put them down the sink.

WHAT TO DO:

1

Fill the tall cup ½ full of water.

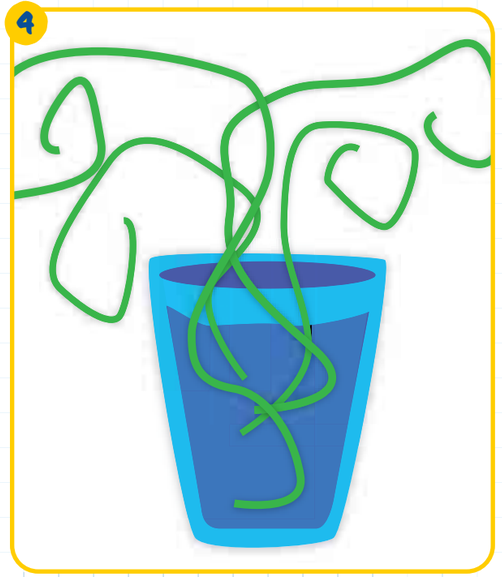
2

Add 1 medium scoop of calcium chloride and stir the solution until the powder is dissolved.

3

Squeeze a long steady stream of sodium alginate into the cup. Repeat until you have several long strings.

4



Pull your worms out of the water! Or let them soak and see if they become more solid.

WHY DID THAT HAPPEN?

When the sodium alginate meets the calcium chloride, the two chemicals react to create calcium alginate—a gooey, gelatinous material—and ordinary table salt (sodium chloride). The gel wraps around water droplets to form soft beads or worms. The longer the worms soak in the calcium chloride, the more calcium seeps in and links to the gel, making the worms firmer.

AMAZING FACTS!

Sodium alginate is extracted from brown seaweed or kelp, which is a form of algae. That's where it gets the "alginate" part of its name. Carrageenan, an extract from red seaweed, thickens puddings, jams, and even chewing gum.

Make Gooey Glowing Worms

Now let's make worms that glow in the dark!

FROM THE KIT:

- Sodium alginate solution
- Calcium chloride
- Medium scoop
- Small scoop
- Zinc sulfide
- Tall cup
- Beaker

WHAT TO GET:

- Room temperature water
- Strong lamp or UV light

Safety First! *Make sure to use your safety goggles and experiment tray.*

When you are done with the worms, they can be safely thrown in the trash. Do not put them down the sink.

WHAT TO DO:

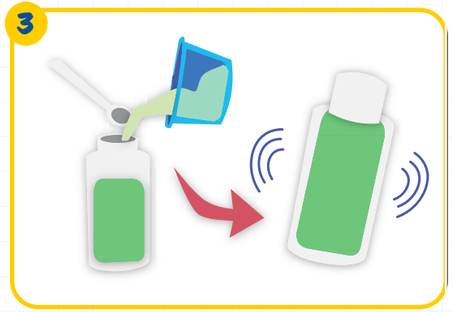
1

Add 1 big scoop of zinc sulfide to the short cup and spread the powder out evenly. Let the powder sit directly in sunlight or under a lamp for 1-5 minutes.

2

While your zinc sulfide is energizing, fill the tall cup 1/2 full of water. Add 1 medium scoop of calcium chloride and stir the solution until the powder is dissolved.

3



Carefully remove the cap from the sodium alginate bottle. Use the small scoop to add all of the energized zinc sulfide into the bottle. Tightly screw the cap back on the bottle and **shake well** to combine all the ingredients.

4

Squeeze a long steady stream of the energized sodium alginate into the cup of calcium chloride solution.

5

Turn off the lights and pull your glowing worms out of the water. If the worms start to fade, shine a light on them to make them glow again!

WHY DID THAT HAPPEN?

Like all light, UV light is a form of energy. When it hits phosphorescent substances it excites their electrons, giving them extra energy that causes the electrons to move into a higher orbit around the nucleus of the atom. When they return to their normal orbit, they must give off energy, which we see as visible light.

AMAZING FACTS!

Forensic detectives use UV lights to reveal many things that appear invisible under normal lights. By using fluorescent powders, they can detect fingerprints and various bodily secretions like sweat, which can sometimes fluoresce.

Rainbow in a Test Tube

Some polymers stretch out so much that they can absorb hundreds of times their weight in water. The jelly crystals in this kit are a "super-absorbent" polymer—and they make gooey fun!

FROM THE KIT:

- 1 test tube
- Short cup
- Tall cup
- Beaker
- Color tablets (1 red, 1 blue, and 1 yellow)
- Jelly crystals
- Medium scoop

WHAT TO GET:

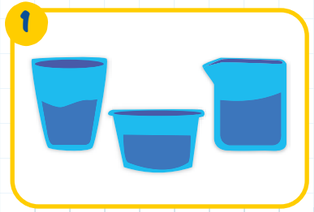
- Warm water
- Paper towels

When you are done with the jelly crystals, they can be safely thrown in the trash. Do not put them down the sink.

This experiment takes longer than the others. Total time is up to 24 hours.

WHAT TO DO:

1

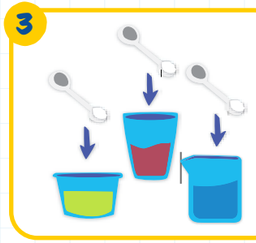


Measure 30 mL of water with the beaker and add it to the tall cup. Repeat and fill the short cup. Then fill the beaker with 30 mL of water so you have 3 vessels of equal amounts of water.

2

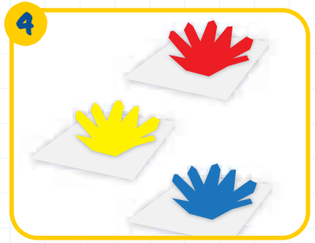
Add one color tablet to each vessel of water and let the color fully dissolve (10 minutes).

3



Add 1 medium scoop of jelly crystals to each water-filled vessel. Allow the crystals to sit until they soak up all the water. This can take up to 24 hours.

4

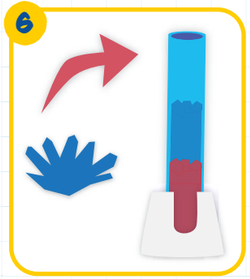


Scoop out your colored jelly crystals from each cup and put them on a paper towel to absorb any extra liquid. Don't let the three colors of jelly crystals touch yet!

5

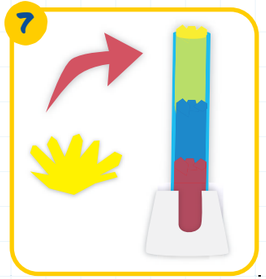
Choose your first jelly crystal color and drop some into the test tube until it is ⅓ full.

6



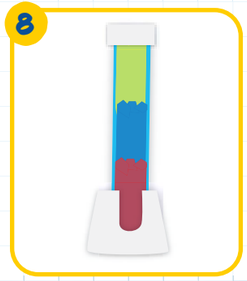
Add the same amount of your second color to the test tube.

7



Add your third color, making sure the crystals slightly overflow the tube.

8



Squish the crystals down with the cap of the test tube and close it tightly.

9

Turn the test tube upside down. The crystals will sink into each other. After a few minutes, you'll notice the colors begin to mix. The primary colors (red, yellow, blue) mix together to form secondary colors (orange, purple, green). If you wait a few days, the colors will fully mix together to form a rainbow!

AMAZING FACTS!

Because super-absorbent polymers can absorb and trap so much water, they are used in diapers, hair gel, surgical sponges, and detergents. Florists and plant nurseries also add them to soil to act as a long-lasting water reservoir. The water is trapped in gel instead of running through the soil, and when the plant's roots need water, they suck it out of the gel. The really cool thing is that the next time the plant is watered, the process starts all over again, since the crystals can be used over and over.

Make a Colorful Crystal Tree

The smallest building block of a crystal is called a *unit cell*. When the unit cell attaches to a solid surface, the crystals begin to grow. Given the right conditions, there is really no limit to how big a crystal can get.

FROM THE KIT:
- Washable markers
- Display base
- Pack of crystal growing liquid
- Paper tree

WHAT TO GET:
- Scissors

Safety First! *Make sure to use your safety goggles and experiment tray.*

This experiment takes longer than the others. ***Total time is up to 8 hours.***

WHAT TO DO:

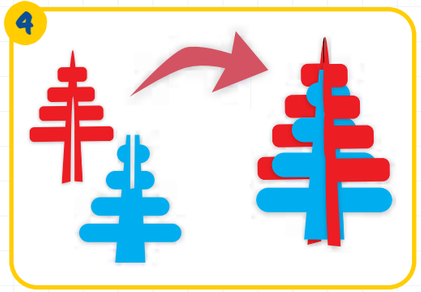
1. Pick a safe location for your tree to grow, where it won't be touched or disturbed. The crystals on your tree will be fragile and may fall if moved.

2. 

Using the markers included in the kit, color your tree any way you want.

3. 

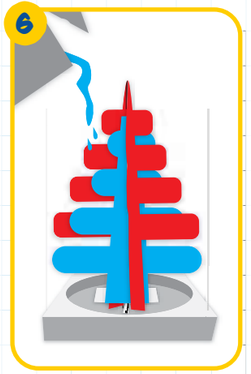
Separate the tips to spread out the branches as desired.

4. 

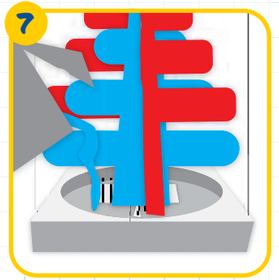
Assemble your tree by sliding the part with the slot on the bottom over the part with the slot on the top.

5. 

Place the assembled tree into the center of the base. Place your tree in the safe location.

6. 

Using scissors, cut a corner of the liquid packet. Carefully pour a small amount of liquid over the very top of the tree. This will ensure the top of the tree grows crystals.

7. 

Pour the remaining liquid into the base.

8. In just 30 minutes, crystals will begin to form on your tree. In 6–8 hours, your crystal tree will have fully bloomed!

TRY THIS! *When the crystals fall off the tree, put them back in the base and add a little bit of water to regrow the tree!*

WHY DID THAT HAPPEN?

The growing solution for your crystal garden contains "bluing," which is a suspension of microscopic particles of a blue powder that give the unit cells something to attach to, allowing the crystals to grow.

SERIOUSLY SCIENTIFIC

Crystals and evaporation

In nature, crystals often grow when water evaporates from a solution, leaving the minerals behind. That's the principle at work in this experiment. The crystal growing solution contains ammonia, which speeds up the evaporation process, letting your crystals grow in a matter of hours.

Make It Red with an Acid! (pg. 6)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

Make It Blue with a Base! (pg. 8)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

The Power of Purple (pg. 10)

Question: _____

_____

Guess: _____

_____

Conclude: _____

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Reveal a Secret Message (pg. 12)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

Hide a Secret Message (pg. 14)

Question: _____

_____

Guess: _____

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Conclude: _____

_____

Atomic Fizz (pg. 16)

Question: _____

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Guess: _____

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Conclude: _____

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Drop by Drop (pg. 18)

Question: _____

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Guess: _____

_____

Conclude: _____

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Blow It Away (pg. 20)

Question: _____

_____

Guess: _____

_____

Conclude: _____

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Turbid-Charged! (pg. 22)

Question: _____

_____

Guess: _____

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Conclude: _____

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Make a Glowing Test Tube (pg. 24)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

Make a Colorful Bouncy Ball (pg. 28)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

Make Instant Worms (pg. 30)

Question: _____

_____

Guess: _____

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Conclude: _____

_____

Make Gooey Glowing Worms (pg. 32)

Question: _____

_____

Guess: _____

_____

Conclude: _____

_____

Rainbow in a Test Tube (pg. 34)

Question: _____

_____

Guess: _____

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Conclude: _____

_____

Make a Colorful Crystal Tree (pg. 36)

Question: _____

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Guess: _____

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Conclude: _____

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Question: _____

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Guess: _____

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Conclude: _____

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Question: _____

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Conclude: _____

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Question: _____

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Guess: _____

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Conclude: _____

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Notes:

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